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PROCESS FOR CARRYING OUT EXOTHERMIC REACTIONS

[Procédé pour l'exécution de réactions exothermiques]

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In German patent No 1 088 030, a process has been described for carrying out exothermic reactions between gases and possibly between liquids, a process in which the hot reaction products, coming out of the reaction container, are first brought into a first heat exchanger in which they transfer part of their heat to at least one of the preheated reaction participants and heats it to bring it more or less to the temperature of reaction; the reaction products are then brought into a second heat exchanger where they again transfer part of their heat so as to produce steam, and then into a third heat exchanger where they heat at least one of the participants in the reaction to bring it to a temperature of at least 50°C, and advantageously from 100 to 200°C, the temperature in the reaction container being adjusted by injecting said preheated reaction product at one or more points. /1*

Moreover, it has now been found that by using the heat of the reaction products, one can produce steam at high pressure or in large quantity, in a simple fashion and with a low reaction temperature, the very hot reaction products coming out of the reaction container are divided into two partial flows, and one directs one of these partial flows to heat exchanger (I) in which it transfers its heat to the possibly preheated reaction participants, and one heats up these participants more or less to the temperature of reaction, and one directs the other partial flow into another heat exchanger (II) where it transfers part of its heat in order to produce steam, and, finally, one directs this partial flow into another heat exchanger (III) where it preheats at least one of the participants in the reaction to a temperature of at least 50°C, advantageously from 100 to 200°C, and the temperature in the reaction container is adjusted by introducing this preheated reaction participant into it at one or more points.

The application of this mode of operation revealed itself to be particularly advantageous in exothermic reactions that occur at medium temperatures, for instance, at temperatures between 300 and 400°C, such as hydrogenation of hydrocarbons, synthesis of methanol, refining processes with hydrogenation, and similar reactions. When splitting the very hot reaction products into two flows, it is

* [Numbers in right margin indicate pagination of the original text.]

vital that the size of one of these flows is sufficient to heat, in a heat exchanger, a part of the raw materials to a temperature that is close to that of the reaction or to a temperature at which the reaction starts. With the other partial current, which, in a variant of the mode of operation described in the aforementioned patent, is available at the actual temperature of reaction, steam is produced at high pressure, or in great quantity at low pressure. The rest of the heat is then transferred to the part of the reaction participants provided for temperature regulation in the reaction container.

In this mode of operation, it is generally necessary to equip heat exchangers (I) and (III) with heat exchange surfaces of very different dimensions. But in industrial installations, the use of heat exchangers of more or less equal dimensions is preferred, because of the possibilities of interchangeability of the various units. The drawback of having to work with different units may, in numerous cases, be avoided if both partial flows of the reaction product are already joined before reaching third heat exchanger (III). The raw materials that are heated in heat exchanger (III) are then divided into two partial flows, one of which is directed into first heat exchanger (I) while the other is sent directly into the reaction container to adjust the temperature.

For the examples described below, reference will be made to the two figures of the attached drawing.

Example 1. (See Figure 1) A fresh synthesis gas, made up of 33% CO and 67% H_2 is brought through pipe 1, and a recycling gas is brought through pipe 34 to a high pressure apparatus in order to produce methanol. Both gases are mixed at point 2. 90,000 standard cubic meters per hour of synthesis gas are brought in, through pipe 3 at a pressure of 300 atmospheres, and divided into two partial flows. The first partial flow – 40,000 standard cubic meters per hour – is brought through pipe 4 and valve 5 into heat exchanger 6 (I), in which it is heated to a temperature of 330°C, by heat exchange, with part of the hot reaction products. The preheated gas is brought through pipe 7 into reaction container 8, which is filled with a zinc catalyst containing chromium. The reaction products exit the reaction container at a

temperature of 370°C, and are divided into two partial flows. One of the partial flows reaches heat exchanger 6 (I) through pipe 9, while the other partial flow is brought through pipe 10 into steam generator 11 (II), in which 3.3 tons per hour of steam at 15 atmospheres are obtained. The reaction products exit the steam generator at 230°C and flow through pipe 12 into heat exchanger 13 (III). Inside it, they transfer their heat to the second partial flow of raw materials – 50,000 standard cubic meters per hour of synthesis gas – which is brought through pipe 14 into heat exchanger 13 (III) where it is heated to 200°C, and then through pipe 15 and pipes 16, 17, 18, 19, 20 and valves 21, 22, 23, 24, and 25 provided in these pipes, into the reaction container to adjust the temperature there. The reaction products exit heat exchanger 13 (III) at 50°C through pipe 26 and valve 27 and enter water cooler 28. The other partial flow is brought through pipe 29 into pipe 26 where both partial flows join at point 30. The whole reaction product is cooled in cooler 28 to normal temperature and flows into separator 32 through pipe 31. At the lower end of the separator, 5,000 liters per hour of methanol are released through valve 33. The recycling gas escapes at the upper end of separator 32, and flows through pipe 34 and circulation pump 35 into mixing station 2, in which it is mixed with fresh gas.

Example 2. (see Figure 2) Fresh synthesis gas with the composition given in Example 1 is introduced through pipe 101. It is mixed with a recycling gas coming through pipe 102. Both gases are injected through circulation pump 103 and at a pressure of 300 atmospheres, into pipe 104. 90,000 standard cubic meters per hour of synthesis gas are brought into heat exchanger 105 where it is heated to 150°C. The flow of gas is then divided. 37,000 standard cubic meters per hour of gas are introduced into reaction container 120 at various points through pipes 107, 108, 109, 110, and 111, and through valves 112, 113, 114, 115, and 116 to adjust the temperature. The other part – 53,000 standard cubic meters per hour - is brought through pipe 117 into heat exchanger 118, in which it is heated from 150°C up to 330°C. This part is then brought through pipe 119 into reaction container 120 and escapes from it at

370°C, through pipe 121. The flow of hot reaction products is divided into two parts. One of the parts flows toward heat exchanger 118 through pipe 122, while the other part is brought through pipe 123 into steam generator 124. Once there, it cools to 175°C and escapes through pipe 125 where it is mixed in pipe 126, with the partial flow exiting heat exchanger 118. The joined partial flows then arrive in heat exchanger 105 mentioned above, in which they are cooled to 68°C, and then go through pipe 127 into water cooler 128 and, through pipe 129 into separator 130 at the bottom of which 5,000 liters per hour of methanol are released through valve 131. The recycling gas is brought back from the upper end of the separator through pipe 102. In the steam generator, 3.7 tons per hour of steam are obtained at 5 atmospheres.

Claims

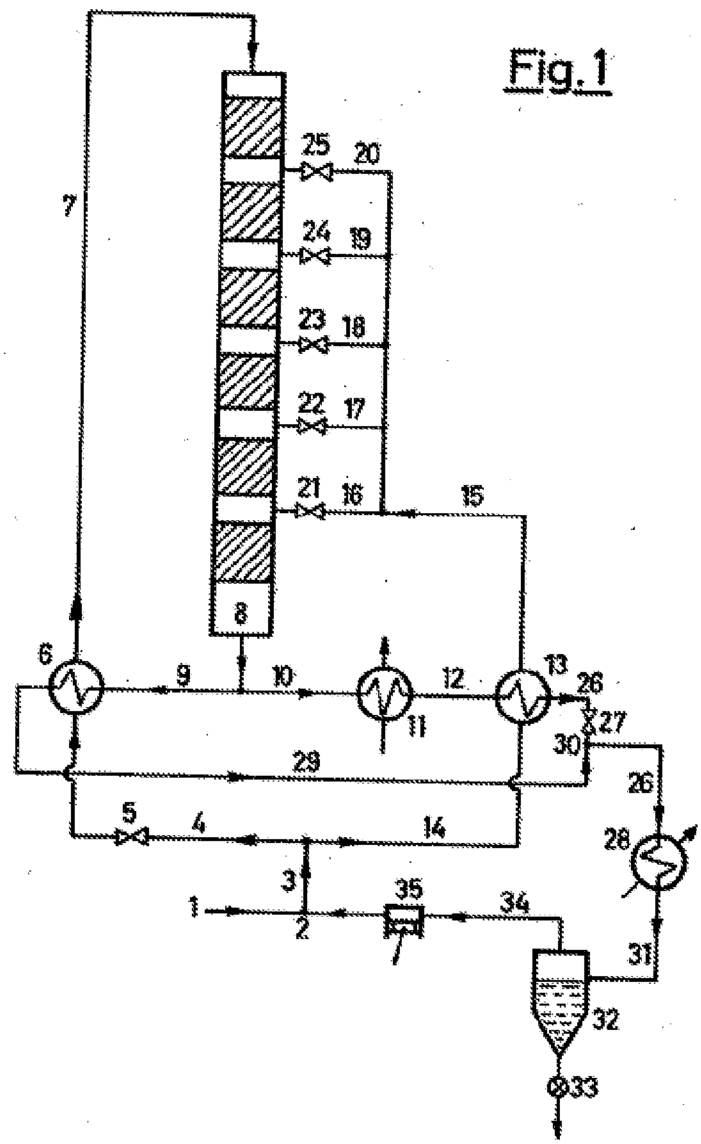
1. A process for carrying out exothermic reactions between gases and possibly between liquids, characterized by the fact that the hot reaction products are divided into two partial flows exiting the reaction container, that one of the partial flows is brought into heat exchanger (I) in which it transfers its heat to the possibly preheated reaction participants and heats them to bring them more or less to the reaction temperature, that the other partial flow is brought into another heat exchanger in which it transfers part of its heat to produce steam, that this partial flow is then brought into another heat exchanger (III) in which it preheats at least one of the participants in the reaction to a temperature of at least 50°C and that the temperature in the reaction container is adjusted by introducing the preheated reaction product at one or more points.

2. A process according to Claim 1, characterized by the fact that the two partial flows of hot reaction products are joined upstream from heat exchanger (III) in which they transfer their heat to the participants in the reaction and that the latter are divided into two partial flows, one of which is brought

into heat exchanger (I) and the other brought directly into the reaction container to adjust the temperature.

3. A process according to Claim 1, characterized by the fact that the preheating temperature in exchanger (III) of at least one of the participants in the reaction is between 100 and 200° C.

Fig.1



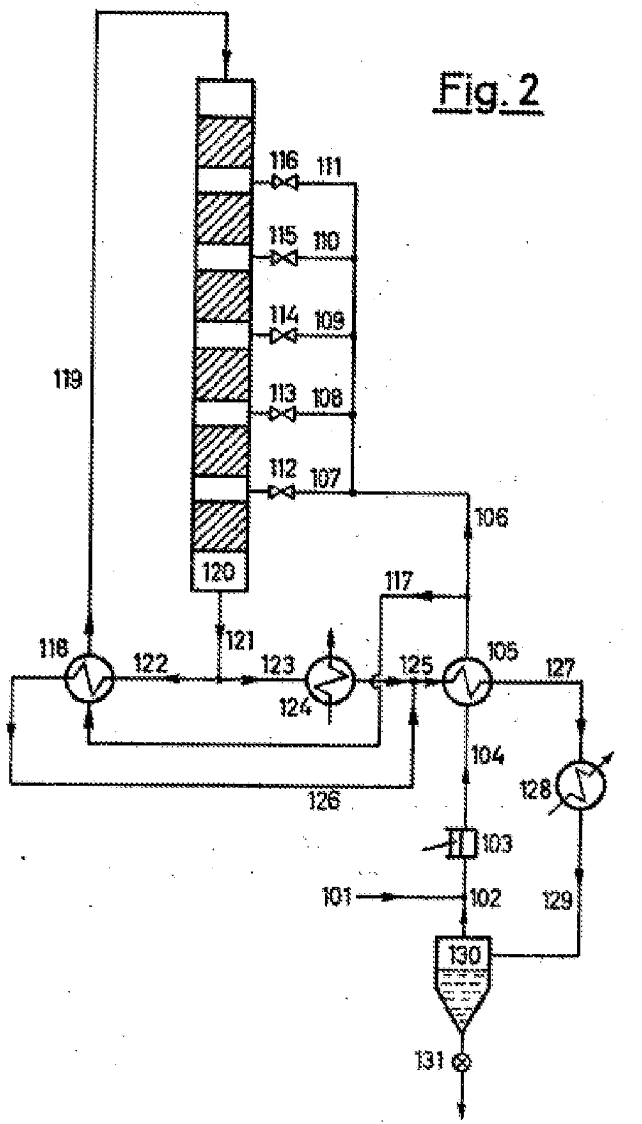

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Fig. 2